TOMOLOGICAL
SOCIETY OF
TISH COLUMBIA

# PROCEEDINGS

OF THE

# ENTOMOLOGICAL SOCIETY

OF

## BRITISH COLUMBIA

(INCORPORATED)

1931

NUMBER TWENTY-EIGHT

Printed by
Murphy & Chapman Ltd., 569 Seymour St., Vancouver, B.C.

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# Proceedings of the Entomological Society of British Columbia

THE 30th Annual Meeting was held on March 21st in the "Daily Province" Board Room, Vancouver, B. C.

The President, J. W. Winson, occupied the chair and the following members were present:—Messrs. Anderson, Beall, Buckell, Bruce, Cianci, Cowan, Downes, Eastham, Finley, Glendenning, Glover, Heriot, Jones, Larnder, Leech, Lyne, Menzies, Olds, Ross, Spencer, Whittaker and Winson.

The minutes of the last meeting together with the report and financial statement were read and adopted.

Discussion took place upon the following subjects:—

Additions to the list of lepidoptera of British Columbia.

Exchange of publications with the Entomological Society of London.

The possibility of continuing to publish our proceedings in view of the cancellation of the Provincial Government grant.

Five new members were elected:—

Messrs. Chapman, K. Graham, F. Grove, A. D. Heriot and Llewellyn Jones.

The following papers were read:—

Presidential Address ..... J. W. Winson

Notes on the life history and control of the Oyster-shell scale ..... A. D. Heriot

**Hemisarcoptes coccisugus,** an enemy of the Oyster-shell scale ..... E. R. Buckell

Notes on woolly-aphis control ..... A. A. Dennys

**Drosophila funebris,** as a host of the fungus **Stigmatomyces** ..... H. Leech

The oviposition habits of **Rhynchocephalus sackeni** ..... G. J. Spencer

Notes on the termite species of British Columbia ..... G. Beall

Chinese insects of commerce ..... J. W. Eastham

Insects affecting holly ..... W. Downes

Plant Quarantines, their purpose ..... H. F. Olds

Record of insects affecting wild life ..... E. A. Bruce and E. Hearle

Parasite introduction into British Columbia ..... R. Glendenning

The presidential address dealt mainly with the success that was attending control work and investigation into insect biology all over the world, and also with the prospects of the Society in view of the financial depression.

The election of officers resulted as follows:—

Honorary President—Francis Kermode.

President—J. W. Winson.

Vice-President (coast)—G. J. Spencer.

" (interior)—E. R. Buckell.

Advisory Board—Messrs. Downes, Larnder, Eastham, Lyne and Whittaker.

Honorary Secretary-treasurer—R. Glendenning, Agassiz, B. C.

Honorary Auditor—J. W. Eastham.

The meeting adjourned at 5 p.m.

# Report of the Secretary Treasurer for 1930

I beg to submit the following details of the activities of this Society for the past year.

### FINANCES

The Society ends the year with a credit balance of $10.90, with no liabilities. $314 has been spent as set forth in the financial statement.

### MEMBERSHIP

Our membership has increased from 30 to 41, and amongst the new members are several good workers.

### PROCEEDINGS

Despite the curtailed grant from the Provincial Government Number 27 of our Proceedings is before you to-day, and I think lives up to our usual high standard of interest and value.

### LIBRARY

A great many accessions of new bulletins and pamphlets have been received during the year but our finances have not permitted the purchasing of any books.

### ADVISORY BOARD

Two meetings of this executive have been held during 1930 when routine matters were dealt with. The preparation of matter for the Manual of B. C. Entomology is proceeding slowly, but many difficulties are being met with.

R. GLENDENNING,
Hon. Secretary-treasurer.

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### FINANCIAL STATEMENT, 1930

| Receipts | | Expenditures | |
|---|---|---|---|
| Balance forward | $ 39.71 | Rent, meeting room | $ 10.00 |
| Subscriptions | 53.00 | Printing | 201.03 |
| Sale of Proceedings | 27.50 | Stamps and envelopes | 13.00 |
| Provincial Grant | 200.00 | Photographic supplies | 11.58 |
| Bank interest | 5.35 | Ontario Society dues | 24.00 |
| | | Secretary's honorarium | 50.00 |
| | | Sundries | 5.05 |
| | | Balance in bank | 10.90 |
| | $325.56 | | $325.56 |

Certified correct,

R. GLENDENNING,
Hon. Secretary-treasurer.

Audited and found correct,

J. W. EASTHAM, Honorary Auditor.

# Some Notes on the Oyster Shell Scale

A. D. HERIOT, DOMINION ENTOMOLOGICAL LABORATORY
VERNON, B. C.

During the past two years a number of observations have been made at Vernon in the Okanagan Valley on the life history and control of the oyster shell scale.

The following article deals mainly with the formation of the scale with which the insect protects itself during its development and its life as an adult.

## Different Stages of the Insect

The eggs when laid are slightly larger than when measured in the early spring being .33 mm. and .28 mm. in length respectively. They are a pearly white and about half as wide as they are long and are covered with a very fine waxy powder. These lie dormant from September until May. The parent scale is so tightly packed that the eggs are pressed very much out of shape. Among them are found occasionally shrivelled specimens showing a discolouration. After the mild winter of 1920-21, Mr. Venables examined 83 scales in March, out of which only four eggs exhibited this discolouration. and he quotes J. D. Tothill in Vol. IX, Bulletin of Ent. Research as saying: "As a rule one rarely finds more than 2% or 3% of such eggs."

Subsequent observations in Vernon during the last two years lead to the same conclusions and as one finds this small percentage of dessicated eggs in the autumn they would appear to be merely accidents. In the spring of 1929 and 1930 following severe winters there were, however, a number of eggs which while retaining more or less their normal shape were brown in colour. The average number for all our counts was only 8%, but in some localities especially on trees in the town of Salmon Arm, the percentage of these damaged eggs was in some cases 90%.

Webster has shown that the eggs will withstand a temperature of -31 degrees F., but will succumb to -32 degrees F. Unfortunately he does not describe the appearance of the eggs when killed by frost.

The minimum temperature for the last two winters in Vernon has been around -24 degrees F. although it is possible that lower readings might have been made from such localities where the severest injury to the eggs was found.

No cause other than cold weather can be assigned for the discolouration of these eggs but the more important point is that these eggs are killed and interfere with the hatching of the sound eggs.

### Incubation of the Egg

The eggs appear to require a period of rest. Samples brought into the laboratory in October show no sign in December of any change. The eggs have been described as pearly white and are just as opaque as a pearl. By examining them in cedar oil and slightly pressing them under the weight of a thin cover glass they are sufficiently transparent to observe from day to day the changes taking place prior to hatching.

The embryo is more or less enveloped in the embryological folds, but on May 4th distinct signs of the chitinous mouth parts could be detected appearing as a faint V. On the 12th the pharyngeal pump could be seen as a small dot at the angle of the V. On the 15th the stylets became visible as an extension of the sides of the V but curving in their course so as to represent two coils on either side of the head. The chitinous ring around the base of the labium was also in evidence.

On the 16th antennae and legs were plainly to be seen and hatching commenced on the same day. Eggs from trees sprayed with oil and lime-sulphur at winter strengths showed a similar development. These dates do not determine the actual time required for this development of the embryo. The method employed required the observation of a number of eggs and are not to be construed as precise data of the changing phases within a single egg. It is, however, possible to predict when emergence is likely to take place and it may be possible to judge the duration of the hatching period by such means.

### Hatching and Emergence

While the development of the embryo has been proceeding, the eggs which are packed so tightly within the scale as to be much flattened. have been gradually resuming their normal spherical shape in which they were first laid. Covered as they are with a powdery wax they are able to accommodate themselves to an expansion of the egg mass which by the swelling of the eggs must inevitably take place. This expansion appears to lift the posterior end of the scale which is the only part not attached to the bark by a ventral skin and thus an exit is provided for the hatched nymphs.

This period appears to be the most critical in the life of the oyster shell scale. A percentage of dessicated, winter killed, or otherwise injured eggs which cannot regain their normal shape must collapse under pressure and thus prevent the expansion necessary to lift the scale and provide freedom of exit to the enclosed nymphs. If, on the other hand, there are no injured eggs, but their waxy covering is destroyed so that the eggs adhere to each other, the mass will nevertheless expand but the pressure will be unevenly distributed and many eggs may collapse. Moreover, a compact mass of eggs would make it very difficult for the young nymphs to get out of the egg.

Nature, in the case of the oyster shell scale, seems to have contrived such a well-adjusted piece of mechanism that a very slight interference may put the delicate machinery out of gear.

Providing all goes well during the hatch, the egg at the extreme caudal end, which were laid a month earlier than those of the anterior

end, will be the first to hatch. As these first nymphs leave the parent scale space is provided for eggs to separate from the mass and so on until all the nymphs have had room to struggle out of their envelope and pass through the exit in orderly succession. It is quite another matter if cold or wet weather intervenes which may disincline the first hatched nymphs to venture forth. These may in this case die or linger at the exit or completely block the doorway by settling down and starting their preliminary scales, but whatever they may happen to do under varying circumstances, their presence within the scale is apt to cause a congestion that is of fatal consequence to the rest of the family.

Much of the above can be confirmed observationally. That the caudal end of the scale is firmly attached to the bark until the spring is verified by the fact that in so many cases in the autumn one finds that the mite **Hemisarcoptes coccisugus** has to force an entry through the thin exuviae or cast skins at the anterior end of the scale.

That pressure is exerted by the expanding egg mass in the spring is demonstrated by the manner in which the eggs scatter when the scale is detached from the bark, which does not happen in the autumn.

The large number of dead nymphs and partially hatched eggs that are found beneath the scales when the weather has been unfavourable at the time of emergence makes the description given of what takes place under certain conditions more than a matter of mere conjecture.

However careless Nature may appear to have been in providing for every contingency a further scrutiny of the insect during the making of the scale will at least show how painstakingly Nature endeavors dur-during the insect's life to provide against the weather, especially wet weather.

### The First Instar

The nymphs extricate themselves from their surrounding envelope in much the same way as during a moult. The anterior end of the egg breaks, setting free the head and the thin membrane gradually splits until the legs are freed and the insect is able to quickly disengage itself from its covering.

The newly emerged nymphs are creamy white in colour. They are smaller but similar in appearance to the tiny lenticels on the smooth young bark which to the unaided eye may easily be mistaken for settled nymphs. There are two small lemon coloured areas, one being at the caudal end and the other at the anterior. In the neighbourhood of these yellow areas are scale producing organs.

The antennae protrude slightly ventrad being composed of six segments, the distal segment is as long as the first five and is armed with six stout spines. The length of the antennae is not more than equal to the breadth of the head.

The legs are stout, the tarsus ending in a single claw around which are four projecting capitate hairs (digitules).

The simple eyes have only one lens behind which is a bright red pigment. It is only during the short active period before settling that the

legs, antennae and simple eyes are of any service, these all being cast away in the first moult.

The labium appears as a small chitinous ring when viewed from above. Laterally this is seen to be a small half sphere like a pimple projecting the length of its width and down the centre of this is a vice-like process whereby the stylets are gripped.

The long stylets, mandibular and maxillary, which were coiled in the head of the embryo immediately before the hatching of the egg have coalesced and moved down and when viewed in the nymph they extend from the mouth to the pygidium where they curve back to the centre of the body. Here they form a small loop and then double back to the pygidium and return to the mouth, terminating in the short labium. The length of the stylets is considerably greater than the length of the insect and the uses of this excessive length will be more evident at a later stage.

The pygidium at this stage is segmented to become hereafter fused in the adult. The median lobes are very wide apart between which protrude a pair of very long setae, more than half the length of the body. These trail behind the nymph as it moves and probably assist the creature in adhering to the smooth bark. Incidentally the predaceous mite **Hemisarcoptes coccisugus** Lignieres is also equipped with similar appendages. Laterad to the median lobes are a paid of rudimentary secondary lobes and between the lobes and projecting from the margin of the lower abdomen are 8 to 10 blunt gland spines resembling nipples rather than setae. These are the spinnerets, which with two large wax pores of the head in the centre of the lemon coloured areas at the anterior end, manufacture the preliminary waxy covering.

### The Active Stage After Emergence

On leaving the parent scale the activity of the crawling nymphs appears to be largely dependent on temperature.

Experiments with a twig of heavily infested dogwood have shown that at 64 degrees F. in the laboratory the emerged nymphs were reduced to a comatose condition. Taken into the sunshine at a temperature of 85 degrees F. the same twig became a seething mass of movement. Repeated trials proved beyond doubt the effect of light and temperature.

Quayle has shown that the distance travelled by **Lepidosaphes beckii** Newn. at a temperature of 89 degrees F. was three times the distance attained at a temperature of 68 degrees F. He has further demonstrated that the insects are attracted towards the light. The question of how long and how far the insects crawl before settling must therefore vary according to light and temperature.

Grace Griswold in three experiments with the lilac form showed that it only required an hour or so for this form to settle and that the scales are completed within from thirty to forty-eight hours.

Similar experiments in Vernon were inconclusive owing to weather conditions but were sufficient to indicate that the crawling period of the apple form is at any rate of brief duration. From the control point of view this stage would seldom if ever permit of 100% control. Under

optimum conditions hatching and emergence must be a matter of days and under unfavourable conditions may be extended for five weeks. In 1930 the eggs started to hatch May 16th, and an examination on June 23rd revealed the presence of newly emerged nymphs and a few unhatched sound eggs.

The distance that the nymphs crawl does not have to be very great to be harmful in the case of the apple with its short fruit spurs, and it is possible that the effect of a dormant spray may be such as to drive the nymphs on to the unsprayed new growth.

### Formation of the First Preliminary Scale

Shortly after settling a number of fine filaments of a bluish white colour are seen to emanate from the spinnerets or gland spines around the margin of the lower abdomen. At the same time two coarser strands of a metallic lustre proceed from the two large wax pores of the head. These coarse strands directed backwards from the head coil on the body much like the spring of a watch and in doing so catch the finer strands of the pygidial gland spines. This warp and woof gradually produce a clumsy coat which hides all but a small portion of the head.

Under this preliminary and elastic covering the insect is able to develop and grow, but this coat is soon lost and does not form any part of the completed scale.

### The First Moult

At the first moult the insect remains in situ and does not cast its skin away, but makes use of it as a protective casing. The dorsal skin has gradually hardened and thickened into a shell and at the moult loosens and becomes free. The ventral skin has meanwhile remained thin and flexible and breaks at a point just caudad of the antennae. This thin venter is pushed down enabling the second instar to come in contact with the bark while closely confined beneath the hard dorsal skin (the exuvia). In this moult the antennae, the legs, the eyes and the long setal trailers are dispensed with. The redundant antennae adhere to the anterior end of the exuvia and the discarded legs are visible in the crumpled ventral skin at the posterior end.

A set of stylets have been formed and are coiled within the head previous to the moult in the same position as they appeared in the head of the embryo within the egg previous to hatching. The old stylets are not withdrawn but remain embedded in the tissue of the bark.

### The Second Instar

The second instar ensconced beneath the first exuvia is minus antennae and legs and without organs of sight. It is pear-shaped the posterior end being somewhat broader than the anterior. The colour is creamy white as in the first instar but there is only one lemon coloured area and this is at the caudal end. Now that protection is afforded by the first exuvia the anterior wax pores have served their purpose and cease to exist. Instead of advancing from a simple larva to a more organized form of existence, the scale at first sight seems to have a retrograde metamorphosis from a nymph with the sense organs

and appendages of an adult insect to a distinctly larval type of form. A closer acquaintance with the second instar will enable one to appreciate the fact that a very great advance is really in progress, namely, an advance from an unspecialized nymph to a highly specialized adult, in which the centre of interest lies in the pygidium.

This has undergone considerable change. The large median lobes are much closer together and the secondary lobes more distinct. The stubby spinnerets have become more spine-like. Four large piston-shaped glands are developed on either margin of the pygidium and two others appear in a rudimentary condition. None of these appear to have any role in the formation of the second temporary scale which again emanates from the gland spines.

This time the first exuvia and its clumsy covering form a matrix for the succeeding coat. Instead of the waxy filaments extending into space and being haphazardly caught by the coarse strands from the head they strike the low ceiling of the first exuvia and a sweeping movement to and fro of the insect's lower body weaves these threads compactly. This movement of the insect makes its second coat, which by the way is very much better than its first attempt—considerably wider than the insect beneath and it is only during the second stage that the appellation oyster shell scale is really suitable.

Two or three weeks elapse before the second moult which is a repetition of what took place in the first. The dorsal skin hardens and becomes free while the ventral skin breaks at the anterior end and is pushed down to allow the adult to have free access to the bark.

### The Third Instar or Adult

The adult is very similar in appearance to the second instar. The new stylets are considerably longer and for a short time after moulting are extended in several graceful loops within the body.

The drawings by Grace Griswold of the lilac form give a different contour of these loops to what is observed in Vernon on the apple form. A very eccentric arrangement of the stylets has been observed in the two specimens of **Aspidiotus pinifoliae** which were caught at this particular stage. It would appear that a particular pattern of these loops is constant to the different species and probably to variations of the same species.

The pygidium shows several alterations. The median lobes are very close together and are notched on their margins. The second lobes are cleft to form two distinct lobes but the purpose of these lobes is obscure.

The gland spines are now in pairs instead of single, one pair projecting between the median lobes and four pairs projecting on either side from the margin of the pygidium making nine pairs in all. Above the pygidium several gland spines are prominent on the sides of the abdominal segments and a number of stubby spinnerets similar to those of the first instar are scattered over the ventral surface of the sides of these segments. The large piston-shaped glands which were evident but were not at work in the formation of the second covering are now twelve in number and in good working order.

All these scale producing organs are thus situated more or less on the outer margin of the body.

The anus is situated on the dorsal surface some distance from the extreme posterior end and it appears that the waste matter from the body is incorporated in the final scale.

In addition a number of small pores are scattered on the dorsal surface of the pygidium which do not seem to produce scale material but may excrete a substance that gives the scale its inner polished surface.

On the ventral surface there are five groups of circumgenital pores. There being two posterior and two anterior lateral groups and one median group arranged in the shape of a horse shoe around the vulva. Each group consists of about 12—15 pores and each pore has a central flower like structure consisting of 5 and sometimes 6 roundish cells surrounding a central cell. This cell arrangement is exactly similar to the head wax pores of the woolly aphis **Eriosoma lanigera** Haus. From the circumgenital pores is derived the waxy powder with which the eggs are covered. Similar pores are found around the two pairs of spiracles where this waxy secretion is also encountered.

## Formation of the Scale

The thick dorsal scale is made up of thread like filaments emanating from the gland spines as on previous occasions, but in addition a thick ribbon-like material is exuded from the large piston shaped pores. The waste matter from the anus provides further material and the small dorsal pores may emit a substance which counteracts the adhesiveness of this mixture. The movement of the insect's body from side to side so enlarges the scale that it allows for the growth of the insect and also enables it to move down the lengthening scale. Simultaneously the spinnerets on the ventral margin of the abdomen are engaged in producing the fine material of which the thin ventral scale is composed, but these spinnerets being situated towards the middle of the body, the ventral scale does not extend to the full length of the dorsal scale thus when the scale is raised an opening is provided for the hatching nymphs to crawl through.

The formation of the scale can only be deduced by observing insects denuded of their covering. Most of these die very soon but some will continue to produce scale material for several hours. Under these very adverse circumstances the rate at which these threads are produced is about 1 mm. in 10 hours. Allowing 30 days for the completion of the scale and the number of organs employed there must be considerably over 30 yards of this material in the completed scale under normal conditions if production is constantly maintained.

The completed scale measures from 3—4 mm. in length being over 4 times the length of the insect beneath. It is during the construction of the scale that the uses of the extraordinary length of the stylets becomes apparent. These have been seen to be lying in several graceful loops within the body immediately after the last moult. Only a part of

this great length is inserted into the bark for in order to reach the cambium it is only requisite that one-third of the length of the stylets should be thus employed. But the insect must move down the lengthening scale and as this takes place the reserve length within the body is utilized. This is pulled out of the body so that on completion of the scale the insect is at the posterior end with its stylets stretching tautly to the tiny orifice in the venter where they were originally inserted. If during the construction of the scale the insect is detached by a sharp razor blade which serves the stylets, a considerable length of styles will be seen to be conserved within the body.

### Filling the Scale

On completing the scale the insect has become cylindrical in shape and its body is replete with eggs in all stages of development. It proceeds to deposit these as they mature and as it does so works its way back to the anterior end. This takes a matter of a month or so, the body contracting as the eggs are disposed of and the life history comes to an end in September when the scale is so packed with eggs that there is no room for any more and the shrunken adult is squeezed into the extreme anterior end where it first moulted. The number of eggs show a range from 21—77.

Grace Griswold's counts range from 20—108 for Ithaca, New York. The number of eggs varies with the size of the scale and in some years the scales are larger on the average than in other years. Large scales with few eggs are not met with and the insect appears always to have the ability to pack to the utmost the scale which it provides.

Both the apple and lilac forms of **Lepidosaphes ulmi** appear to be completely parthenogenetic on their common host plants. Grace Griswold says "During the past two years I have examined thousands of scales from many host plants but have never seen a male." Imms (1925) says "In **Lepidosaphes ulmi** (L.) males are unknown on its commonest host plant (apple) and have only been observed on one or two less frequently infested plants."

There is no record of a male being observed in B. C.

# Hemisarcoptes coccisugus Lignieres

## An Enemy of the Oyster Shell Scale

E. R. BUCKELL, DOMINION ENTOMOLOGICAL LABORATORY
VERNON, B. C.

**Hemisarcoptes coccisugus** belongs to the family Canestriniidae or Insect Mites. This is a small family of predaceous mites which feed principally upon insects and their eggs. Many of these mites live on beetles, but this particular species feeds on the eggs and young of scale insects, especially the common oyster shell scale. In California it feeds also upon the San Jose Scale and probably other scales are attacked.

Mites are of great interest not only because of their minuteness; their varied forms and adaptations for living under widely different conditions, but also because of their complex inter-relationships and their influence on the welfare of man by direct attacks and by infesting domesticated animals and plants.

There are a very large number of mites and the majority of them must be classed as injurious to man's welfare.

Among these may be mentioned the Red Spiders, which attack practically all kinds of citrus trees, almond, apple, pear, plum, prune, other fruit trees, as well as ornamental and native shrubs and plants; the chicken mite, a serious pest of poultry; the bulb mite, injurious to many plants and particularly to bulbs such as freesia, hyacinth and narcissus; the scab mites, which cause mange of animals, and the pear leaf blister mite, which attacks the leaves of apples and pears.

The beneficial mites are far less numerous, but mention may be made of the locust mite, which feeds upon the eggs of grasshoppers and which may be seen attached to the wings of adult grasshoppers. There are also a few other predaceous mites which feed on the eggs and young of some of our injurious insects.

**Hemisarcoptes coccisugus** occurs in Europe, Canada, and the Eastern States.

It did not occur in British Columbia until its introduction from Eastern Canada to the Vernon district in 1917 by Treherne. It was liberated on apple trees and wild bushes and soon became established.

It spreads very slowly but has now become common in parts of the Vernon district. It is principally of value in controlling the oyster shell scale upon the wild bushes such as swamp dogwood and thorn. It has reduced the infestation of scale on these bushes in the Vernon district very materially.

It is also of value on apple trees, but unfortunately is killed by the sprays applied in oyster shell scale control.

This mite is being introduced into other fruit growing districts of the province by the Dominion Entomological Laboratory at Vernon, and has already become established in the Salmon Arm area. Liberations are made mainly amongst the scales on swamp dogwood and thorn along creeks and in waste land, where the reduction of the scale will undoubtedly help to keep the orchards from being re-infested.

This is a small, active, pearly-white mite, a little larger than an oyster-shell scale egg. Where it has become well established several mites may be found beneath one scale, where they destroy the eggs or newly hatched young.

Very little is known about the life history of this mite, but we have found that it lays from 15—20 eggs.

It is probable that this mite spreads very slowly and cannot be relied upon to aid very much in orchards where regular scale control is practiced. Its place is along creeks and patches of bush adjacent to orchards where it can help to reduce the oyster shell scale on wild bushes upon which scale control is not practiced.

# Aphelinus mali Hald

## A Parasite of the Woolly Aphis

E. P. VENABLES, ENTOMOLOGICAL LABORATORY,
VERNON, B. C.

The control of injurious insects by parasites is a subject which is receiving a great deal of attention at the present time in all parts of the world.

This special phase of insect control is now, as a rule, in the hands of specialists who devote themselves to the study of the subject in all its aspects. In various parts of the world parasite laboratories have been established, which serve as centres of distribution of the desired species over wide areas. In Canada, the Dominion Entomological Branch has a parasite laboratory at Belleville, Ontario, where a staff is maintained for supplying parasites for all parts of the Dominion.

The promiscuous introduction of parasites into various districts is received with little favour. The danger of introducing, with desired species, secondary, or hyper-parasites, is one of the reasons for exercising particular care in this work. Such an introduction would possibly result in the destruction of the parasite itself.

The best method of shipping the insects, whether in the adult, larval or egg stage, much be studied carefully, and be the subject of experiment before any extensive shipments are made.

In our work dealing with the control of the woolly apple aphis, **Eriosoma lanigera** Haus. in the interior of British Columbia the natural enemies of the insect have been studied. Among the large number of predators attacking the insect Syrphid flies are probably the most important; their influence reaching its maximum of efficiency late in the season.

In certain sections of the United States, and in Eastern Canada, the aerial form of woolly aphis is attacked by a minute Chalcid fly known as **Aphelinus mali** Hald. This insect confines itself to destroying those aphids on the upper portions of the trees and has little influence upon the forms attacking the roots. The absence of the root form of the woolly aphis in the Okanagan Valley, together with the absence of the parasite **Aphelinus mali** Hald, was a matter of interest. The serious infestations by the aerial form of the woolly aphis in the district coupled with the connection of the insect and the Perennial canker disease of apple trees, suggested the advisability of introducing the insect.

The successful introduction of **Aphelinus mali** into many parts of the world has been carried out with excellent results. The parasite has become established in England, France, Japan, New Zealand, Australia, and Uruguay, to mention only a few of those countries, into which the insect has been artificially introduced.

Regarding both New Zealand and Australia it is from these countries that the most optimistic accounts have appeared dealing with the control of the woolly aphis by the Aphelinus. In New Zealand the parasite was widely spread during 1922 and 1923, becoming well established at all points of liberation. Its effect upon the woolly aphis was such that those in touch with the fact surrounding the infestations were of the opinion that the parasite would, under normal conditions, so reduce the number of the aphis that the necessity of spraying would be tremendously reduced.

In New South Wales the Aphelinus has done excellent work. Dr. Tillyard who was responsible for the introduction of **Aphelinus mali** Hald. into Australia shows that the results have been quite spectacular.

It is of interest to note that **Aphelinus mali** Hald. existed in New South Wales prior to its introduction from New Zealand, and was bred from the Chrysanthemum aphis, as recorded by Mr. W. B. Gurney in the Agricultural Gazette of New South Wales, 1926. The stock brought from New Zealand, however, attacked the woolly aphis and is thoroughly established.

In France the parasite is established but the natural predators of the woolly aphis so reduced the insects that the stock of Aphelinus became somewhat depleted each season, although being well establishd.

Regarding the work done with Aphelinus in the Okanagan, the parasite was imported in 1929 from Ontario. Mr. A. B. Baird, in charge of the Dominion Parasite Laboratory at Belleville, undertook the rearing of the parasites, which were shipped to Vernon as they became available.

The first shipment was sent off on August 28th and arrived in Vernon on September 3rd. Nine shipments were received, and a total of 508 living parasites were liberated during September. These insects were all sent in the adult stage.

Various methods were tested in making these shipments. A considerable number were sent in small vials, enclosed in thermos flasks. In some cases the vials were enclosed in flasks enclosing water, the vials being corked and the corks waxed. Others were enclosed in small ice boxes with the vials in racks.

A few shipments were sent by air mail.

The most successful method, and the one resulting in the lowest mortality, consisted of vials wrapped in cotton and packed in wooden boxes with no other protection. The parasites sent by this latter method arrived in excellent condition.

In most cases each vial was provided with half a raisin which was pinned to the cork. This supplied moisture and food for the parasites, which were observed to feed upon the cut surface of the fruit.

The parasites, as received, were liberated on woolly aphis infested trees in the Vernon district. Practically all the insects were placed on a single tree at Coldstream, which carried a very heavy infestation. In

liberating the Aphelinus the corks were removed from the vials and the latter were stood up in a box in the tree and the parasites allowed to make their way out. Several cases of oviposition were noted as soon as the parasites reached a colony of aphids.

At the present time, we are unable to say what the results of the importation of **Aphelinus mali** may be in the future.

Under Okanagan conditions the woolly aphis passes the winter at the base of trees, on the water sprouts, at ground level, and also upon the trunks and main limbs in knot holes, and various protected situations caused by mechanical injuries to the bark; pruning wounds and sun scald cankers are favorite sites in which the insects may winter successfully.

The mortality among the aphids is heavy during cold weather, and only a small percentage of the autumn infestation survives.

The destruction wrought by the winter, combined with the attack of Syrphid larvae in spring may, at times reduce the numbers of aphids to such an extent as to reduce the chances of the Aphelinus from finding a sufficiency of woolly aphids in which to lay their eggs.

In France the numbers of Aphelinus are at times seriously depleted by the attacks of aphid predators and other causes.

At Vernon we are cageing in the tree in which the Aphelinus were liberated; this tree will be artificially infested with aphids this spring in order to secure a plentiful supply of material for the parasite to work upon.

This tree will be used as a centre of distribution for the parasite during the next few seasons.

# Drosophila funebris
## as a Host of the
# Fungus Stigmatomyces

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On February 10th, 1931, a **Drosophilid** fly appeared on my bedroom window. Now Drosophilids are apt to turn up on any window at any time of the year and somehow always find their way into my cyanide jar. But this one was not behaving quite normally; it had either been out the night before and had fallen into a dust heap, or it was decidedly ill. Therefore I made certain that it entered my poison bottle immediately.

Upon examination later, the fly was found to be quite heavily infested with what seemed like minute, swollen, yellowish bristles projecting at odd angles from its body—not at all normal bristles of Diptera and certainly not the armature of the normally smooth-looking Drosophila. Professor Spencer of the Department of Zoology at the University, to whom I submitted the fly, suggested that the "bristles" were probably the fruiting bodies of a species of **Laboulbeniaceae** and this was verified by Professor F. Dickson of the Department of Botany.

Any form of life that might turn out to be parasitic on insects is worth investigating so I looked up references on this growth and found that the fungi of the **Laboulbeniaceae** are rather closely related to the mildews, and though in all cases, are so small as to necessitate the aid of a microscope in studying them, yet are exceedingly interesting because of their peculiar habits. Approximately 152 species have been described up to the present, belonging to 28 genera and their distributional records show a few only in Europe, a few in the tropics of Asia, Africa and America, but a comparatively large number of species in North America. The known species live on insects, particularly those that are found in damp places or are entirely acquatic such as certain Diptera, Neuroptera and Coleoptera. They seem to favour beetles especially as hosts possibly because of the fact that many beetles hibernate as adults and so are admirably adapted to carrying the fungi through the winter.

Armed with this information, a search was made of the house in which the diseased fly had appeared and several more infested specimens were found on the windows in the basement. A further search showed that this species of fly was breeding in a mixture of rotten potato and carrot which was lying in a corner. Curiously enough, another species of Drosophilid fly was much more numerous in the basement and proved to be breeding in the same material but specimens found were entirely free of the fungus.

One of my references, Harshberger, states (a) that these fungi do not annoy or in any way hurt their hosts and (b) that they are often exceedingly specific in their attachment, being in some cases attached

seems to extend this information for in connection with the first point (a) in all cases the flies were very obviosuly bothered by the fungus and kept incessantly rubbing as much of their bodies as they could reach with their legs. Moreover, in the cases of the more heavily infested flies, there appeared to be a very definite weakening of the hosts which were sluggish, and when kept in confinement with uninfested flies caught in the same basement, died very much more quickly than the latter. This might, however, be attributed to the fact that the infested flies were probably considerably older than the others. In connection with the second point (b) namely specificity of attachment on the host, in all cases examined the fungus seemed capable of growing on any parts of the flies' bodies except on the wings and perhaps on the eyes.

Professor Dickson was kind enough to trace out the material secured and tells me that the parasite belongs to the genus **Stigmatomyces** of which one species **Baeri** attacks houseflies in Europe (Germany) and in North America. Another species of the same genus has been reported as occurring on flies of the genus **Drosophila** and on the same species as those in my collections which I traced out to **funebris** in Sturtevant's (1921) key.

To work out the history of this fungus and its method of attaching itself to the flies, I am maintaining colonies of **funebris** (which is reported chiefly as breeding in vinegar vats but also in decaying anima' matter especially in material which has been preserved in formalin and has dried out) and Professor Dickson in investigating the sporulation and growth of the fungus. Until further work has been done, we cannot definitely state the name of this species of **Stigmatomyces** which differs from most of the members of the Order **Laboulbeniaceae** in being an aerial form and in being so large as to be readily perceptible to the naked eye.

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**Acknowledgment.**

I wish to offer thanks to Dr. F. Dickson for help in connection with this fungus; to Dr. J. H. McDunnough of the Canadian National Museum at Ottawa to whom specimens of the flies were sent and through him, to Dr. J. M. Aldrich who verified our identification of it as being **Drosophila funebris.**

# The Oviposition Habits of *Rhyncocephalus sackeni* Will.

## (Diptera Nemestrinidae)

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At Riske Creek, in the Chilcotin, is a spot that can be duplicated almost anywhere over many miles of the elevated, rolling tablelands that constitute the Range country of the Cariboo. The spot in question is the bottom of a long, very shallow valley, through whose lowest point extends a long, narrow strip of alkaline, sedge-covered soil, flooded in spots each spring, by the overflow from a swamp-meadow a short distance up the valley.

Straight down the centre of this valley runs a line of weather-beaten telephone poles approximately seventy yards apart, passing through an egg-bed of the grasshopper **Camnula pellucida** Scud. on which I was making observations in the summer of 1929.

On the 16th of June, 1929, a fine clear day, my afternoon work took me past one of these poles and on happening to glance up, I noticed a light-coloured fly of a species new to me, which somewhat resembled a Bombyliid or Bee Fly, sitting low down on the wood. Out came a cyanide bottle, the fly was stalked and the bottle clapped over it. To my astonishment the fly took no notice of my movements or of the bottle—in fact, it remained perfectly still, and then I saw that it was laying eggs and continued to lay eggs until it was overcome by the cyanide and dropped into the bottle.

A survey of the pole revealed more flies, all laying eggs, and so unusual was their concentration while doing this that it seemed worthwhile to make a few notes on the matter. In brief:—

Flies were laying eggs on 3 poles only, of the total line down the half-mile-long valley.

As many as thirty flies were assembled on a pole at once.

The lowest fly was 8″ or 9″ from the ground and the highest was estimated to be 15 feet up.

Flies were on the poles for the sole purpose of laying eggs, not for sunning themselves or resting.

All the flies examined had abdomens enormously distended with eggs which they were inserting into cracks in the wood.

The flies resembled light-coloured Bee flies with banded abdomens and the positions adopted were very much those of the cattle Warble fly **Hypoderma lineatum** de Villers sitting on the ground and ovipositing on the flank of a cow lying on the ground.

These flies have long, shiny, pointed ovipositors much like those of the warble flies, although unlike the latter, composed of two closely-apposed portions, and with them greatly extended, they reached right down into cracks in the dry wood to lay their eggs.

Egg-laying could be noted by the contraction movements of the abdomen and the pushing movement of the ovipositor.

In the case of one fly observed, the shortest time taken to lay an egg was 8 seconds, the longest 14 seconds, the average time being 12 seconds, over a period of several minutes.

Individuals were not timed for the whole length of their stay on the egg-laying task, but the positions of several were noted and the pole was revisited during the afternoon at intervals of grasshopper work. Several remained over half an hour; one, for nearly an hour, in one position.

It seemed a good idea to photograph them as nearly natural size as possible. I had only my Goertz Tenax plate camera in the field, and no tripod, and since the use of the double-extension bellows necessary for a natural-size photograph requires great steadiness, some means had to be adopted to ensure this. So with the axe from my equipment in the Ford car, I cut a stake from some dry trees lying on the valley floor some distance away, pointed it to a sharp, flat wedge and proceeded to pound the point into a crack where a fly was laying eggs, about 3 inches below the insect, using the back of the axe for a hammer. The whole pole fairly shook with the blows—but the fly kept on laying eggs. I repeated this job three times on the same pole and got the three photographs shown herewith, taken about 8 inches away from the four flies shown, with the fully extended camera lying balanced on the tent pegs I had driven into the telephone pole. In the area shown in photograph 1 with two flies, were 8 insects within a space of a foot.

I do not know for how many days the flies had been laying eggs on these poles before I found them. I visited them the next day 17th June and made some further observations and at the same hour each day, for the next few days. One of the days was cold and no flies appeared. On the fifth day only two or three were out; on suc eeding days no more were found on any of the three poles.

On several days I was able to note the arrival and departure of these flies. The flight is exceedingly rapid; an approaching fly cannot be noted until about a yard from the post, when it circles about once or twice and settles, or settles directly, and immediately proceeds to search for a crack in the wood, either by walking along with ovipositor trailing, or by alternate short walks and buzzings on the surface for a few inches. As soon as a crack is found the fly inserts her ovipositor and seems to test the wood in some wav. She may either start laying eggs at once or may test several inches of crack before ovipositing, and when started on the job, she keeps on depositing exceedingly minute, thin-oval, pale yellow eggs, filling up the crack to about one-tenth of the surface, when she moves on a step and proceeds to fill up a new spot. The eggs are lightly glued to one another so that wind does not

blow them out of the cracks; there is no covering, so that an egg-mass can be readily seen with the naked eye. Enormous numbers may be deposited in one crack.

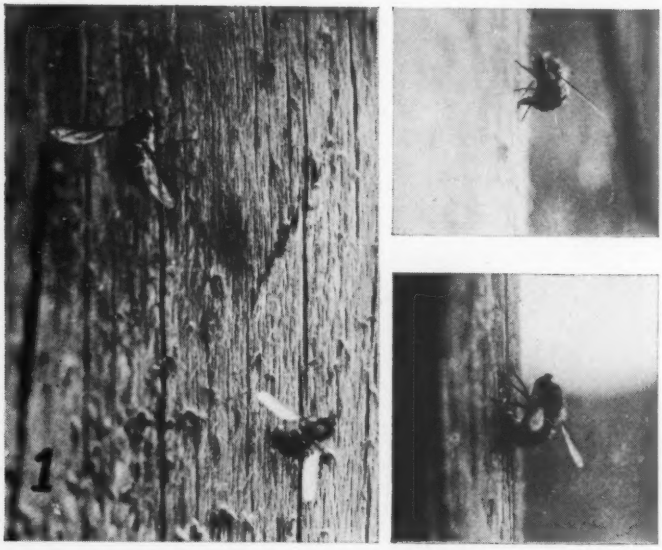
I captured a fly alive and dropped her without food or water into a one-inch diameter shell vial, with a deep narrow cut in the cork to simulate a crack in the telephone pole. As soon as the fly found she could not escape, she located the cut in the cork and proceeded to lay eggs within a few minutes of being captured. She filled up all the lower part of the crack the first day, became a bit feeble the next day although still trying to lay, and was dead on the second morning after capture. I was not able to observe the vial every day following but on happening to pick it up about three weeks afterwards, I found that the inside of the vial was covered with tiny yellow larvae about one-half millimetre in length, all dead, most of them on the cork but some sticking out from the glass at right angles as if standing on their heads or tails.

While engaged in egg-laying, flies may be picked off by hand. If rubbed off a post, all drop straight down, the more heavily gravid ones falling to the ground where they buzz a second and then fly off at great speed, the lighter ones falling a few feet and then taking wing before reaching the ground. If poked gently a few times while egg-laying, they may either take wing immediately or may crawl buzzingly around the pole before flying off. They go so fast that it is impossible to follow their course. They were never met with anywhere else but on these three telephone poles although a sharp look-out was kept for them wherever I went on the range.

The year following, 1930, I visited the area on June 29th and found about forty flies in all on the same three poles, and nowhere else. On the third day afterwards there was only one and no more appeared on succeeding days.

Specimens of the flies were sent to the National Museum at Ottawa and from there to Mr. H. Curran of the Natural History Museum in New York. Mr. Walley of the National Museum very kindly sent me the identifications from Mr. Curran: the fly is **Rhyncocephalus sackeni** Williston of the family **Nemestrinidae** or Net-winged flies, of which only six species have been taken in North America and only eight in Europe. According to Imms, "they are inhabitants of hot, arid regions where there is a minmum of rainfall. They mainly frequent flowers, hovering over them while imbibing nectar." Of the species in question, Williston, in his Manual of North American Diptera, says "But little is known of the larvae. The females of **Hirmoneura** have been observed laying their eggs deeply within the burrows of **Anthaxia,** a wood-boring insect, in the pine rails of fences. The eggs were found in clusters and the young larvae hatched from them differed very singularly from those of a more mature growth . . . on the thirteenth segment there were two pairs of similar setae, the hooks of which, however, pointed forwards, thus enabling the larva to attach itself firmly and to raise itself erect These young larvae emerged in great numbers from the burrows from which they were hatched and, placing themselves erect, were blown away by the wind. Here for a time they have not been followed, but it is probable that they attach themselves by the aid of the ventral hooks

to the bodies of large-sized beetles, by which they are carried into the ground when the females enter to deposit their eggs . . . Females of **R. sackeni** have been observed by Bruner apparently depositing eggs in the stems of **Eriogonum alatum."** The egg-laying habits I have just recorded for **R. sackeni** seem identical with those recorded by Williston for the genus **Hirmoneura,** as do those of the recently hatched larvae. Moreover, the flies I took do not possess the long mouth-parts and the type of wing-venation stated in Williston's key as belonging to flies of the genus **Rhyncocephalus.** I can offer no suggestions as to the habits of the larvae of the flies I found ovipositing: there were no borers in the telephone poles and no timber nearby beyond the rails of a fence encircling a swamp-meadow some distance away. The poles opposite the fence rails had no flies ovipositing in them. The only insects occurring in great numbers all around were grasshoppers and although a large number of these was opened for parasites, the only maggots found were those of **Tachinid** and **Sarcophagid** flies.




Females of RHYNCOCEPHALUS SACKENI Will. ovipositing in telephone poles. Natural size.

# Holly Insects

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## The Holly Leaf Miner (Phytomyza ilicis Curtis)

The climate of the coastal region of southern British Columbia has proved to be very favourable to the growth of holly, both for ornamental and commercial purposes. Very fine trees are to be seen in the city of Victoria and there are also some commercial plantings of considerable size. Unfortunately, when young hollies were first imported, the leaf miner was imported with them and at the present time it is an unusual thing to find a holly bush in any part of southern Vancouver Island or the lower mainland which is not infested with this pest.

The disfigurement of the leaves, while objectionable enough in oramental plantings, is a still more serious matter in hollies that are grown for commercial purposes, the proportion of affected leaves often being as high as seventy-five or eighty per cent. Study of the life history of the miner has been carried out at Victoria, B. C. and from time to time various methods of control have been tried, generally with little success, but during the last two seasons very promising results were obtained by means of nicotine-lime dust against the adults and it appears as if we were getting near a solution of the problem.

The Holly leaf miner belongs to the family Phytomyzidae the members of which are all leaf miners. The adults begin to appear about May 5th with the maximum emergence about the 12th and the emergence continues in small numbers until the end of the month. Within a few days the flies mate and at once being to deposit eggs. The eggs are deposited in the midribs of the young leaves, a puncture being made in the midrib on the underside of the leaf. This occurs when the leaves are very small and scarcely out of the bud stage. At that time the tissue of the midrib is extremely soft and easily penetrated by the fly's ovipositor. The puncture is made generally slightly to one side of the midrib and then the egg is thrust into a position longitudinal with the axis and at right angles to the puncture. The egg is pure white, tapering slightly at the ends, somewhat larger at one end than the other and measures .383 mm. in length by .160 mm. in width. Leaves examined were found to contain from one to five eggs. It is seldom, however, that more than three larvae are found in a leaf and the usual number is only one or two.

The first sign of a mine is seen in August and appears as a small red spot in the body of the leaf. Or it may appear as a narrow red linear mine extending from the midrib. The first mines were noticed on August 8 and at that time it was reckoned that the mine was about ten days old, or rather, that it had taken the larva ten days to advance that distance from the midrib. It was found that the rate of advance was

about a millimeter a day but the progress of the larva was by no means uniform and might cease for a time and then continue. Most of the mines extended from the midrib directly across the leaf in the direction of the edge. There is a discoloured dark area about 2 mm. wide on each of the mine and when the larva is alive the terminal portion of the mine is white or lightish in colour. Should the larva die this becomes entirely obscured by red. The larva when full grown is cylindrical, short, whitish grub about 4 mm. long with black mouth hooks, the anal segments tapering slightly. It makes but little movement when disturbed other than retracing the mouth hooks and first two segments of the body. The course of the mine is by no means uniform. Some take a direct course to the outer edge of the leaf, others may be serpentine, a few take a nearly circular course, while in the case of those that merely make a red blotch the larva seems to remain in one spot, merely making a small discoloured area whch gradually widens. Until after Christmas time the mines are not at all noticeable and are seldom more than one fourth of an inch across at the end of the year. But in January the larva continues to feed during mild weather and in February the mine assumes the appearance of a blotch often with linear ramifications.

Pupation commences in February and in most years is complete by the end of March. Previous to pupation the larva makes a small opening in the cuticle of the leaf. The puparium will always be found close to the opening, sometimes slightly projecting from the hole. Emergence is usually from the upper surface but some of the mines turn downwards during the latter stages and emergence is from the under side of the leaf. The proportion that did so was found to be about 30 per cent.

The puparium measures 2.61 mm. long by 1.18 mm. in width tapering uniformly to a blunt point at each end. It is pale yellowish brown in colour. Both dorsal and ventral sides are flattened. The number of puparia in a leaf varies from one to four.

The adult flies may always be seen frequenting the young shoots and partly expanded leaves and there they seem to feed on any exudate that is present as they were continually noticed to apply the labella to the leaf surface. When so engaged they are very tame and are easily taken with a small collecting tube. Their numbers decrease rapidly during the last week of May and beginning of June and by the third week in June they have usually disappeared.

**Control measures.** Efforts to destroy the larvae within the leaves have proved ineffectual owing to the difficulty of reaching them through the tough tissue of the leaf with any of the ordinary insecticides which are commonly used against leaf-mining insects. Moreover the holly is very susceptible to spray injury and some of the stronger sprays which have been tried, including certain oil emulsions, simply resulted in the hollies casting all their leaves. Up to the present time the best results have been obtained by dusting with nicotine and lime to destroy the adult flies. Owing to the sluggish nature of the insects they lend themselves readily to control by dusting and they are very susceptible to a comparatively weak nicotine dust. In experiments conducted at Victoria, B. C. excellent results were obtained by using a 2 per cent. nicotine-lime dust applied with a rotary duster. The flies are very loth to leave

the holly buds on which they settle and not many appear to escape the dust. They commence to fall within thirty seconds. The average number of dead flies gathered up from beneath heavily infested trees ten feet high was about two thousand but it was not unusual to kill three thousand or more on some of the trees when dusting was carried out during the height of emergence. In view of such results it is not unreasonable to expect that three or more applications of dust would control the fly. Trees that were given two applications of dust in 1930 showed a very definite improvement in 1931 although it was evident that the dust should have been applied earlier, in fact as soon as the flies appeared on the trees. The cost of the dust is from 1½ to 2½ cents per tree and it can be very quickly applied. It is suggested that applications of 2 per cent. dust should be made at weekly intervals, commencing when the flies first appear upon the trees.

**The Holly Bud Moth Rhopobota naevana ilicifoliana, Hb.**

This is another insect which has been imported from abroad and is now present on practically all hollies grown in British Columbia. In some years the infestation is particularly heavy, every young shoot being infested. Fortunately, however, this bud worm does not cause as serious injury to the holly as the miner and does not spoil the holly for market purposes, since the injured shoots are in many cases either covered up or replaced by new growth. It does, however, cause sufficient injury, by checking the young growth and causing it to branch after the injured bud has died and dropped off, to necessitate regular control measures in commercial plantings.

The winter is spent in the egg stage and the young larvae appear in the holly buds as soon as the first young leaves begin to form which is usually towards the end of April or, in backward seasons, during the first week of May. The young larva is at first greenish white in colour with a black head and measures 1.22 mm. in length. At first they live between the terminal leaves of the young holly shoots without spinning any web, and in this stage are easily seen and can be reached by a spray. More than one larva may occupy a shoot at this time and as many as three have been found in one shoot. By the 3rd week in May the majority of larvae have begun to join the terminal leaves together and the tendency for two or more to occupy the same shoot has decreased. As growth progresses a compact case is formed by spinning the leaves together at the tip. The centres of the shoots are now beginning to unroll and in the cylinder thus formed the caterpillar may be found. From this stage onwards not more than one caterpillar will be found in a shoot but each one will have its occupant, and it is hardly possible to find a shoot that is not attacked. The larvae darken in colour with each instar until when full grown they are dull grey green with a jet black head and harmonize well with the colour of the holly leaves. At maturity they measure 10 mm. in length. When disturbed they wriggle out of their nests and drop to the ground. During the last instar the larvae spin together the principal terminal leaves and feed within this case eating back the shoot so that the mass of leaves spun together dies and forms a black unsightly object on the bush which does not drop until it is pushed off by the subsequent new growth. The majority of

the larvae leave the nests when full grown and spin a loose cocoon between dead leaves or rubbish on the ground, very few pupae being found on the trees.

The pupa is pale brown in colour and averages 7 mm. in length. Pupation commences during the first week in July.

The perfect insect measures from 14 mm. to 15 mm. in expanse of wing, the females being usually the larger. Much variation in depth of colouring is shown although the general pattern of the wing remains fairly constant. The inner angle of the fore wings is usually occupied by a patch of dark brown; this is followed by a lighter area which may vary from dark slate grey to nearly white; next to this the wing is crossed by an irregular dark band, beyond this is a nearly circular light patch extending to the outer margin. Other forms may have the general colour of the fore wings, slate grey crossed by two or three irregular bands of mahogany brown. The wing is notched on the outer margin just below the apex. The hind wings are grey brown. Both wings have short fringes, the fore wings on the outer margin and the hind wings on the outer and lower margins. The thorax and abdomen are brown

The eggs are laid singly on the under sides of mature holly leaves, very few being laid on the branches. The egg measures .66 mm. by .83 mm. It appears as a flattened translucent oval body orange red in colour surrounded by a narrow colourless transparent shining border of mucilaginous matter.

**Control measures:** Since the larvae invariably feed from within their nests, stomach poisons alone have been found ineffective and the best control has been obtained with contact sprays against the young larvae shortly after hatching. They can be readily killed by such sprays if the operation is carried out before they have begun to spin the terminal leaves together. Since the hatching period may extend for about two weeks a second spraying should be given at the end of a week's time. The best results have been obtained with the following combined spray: Water 3 gallons, nicotine sulphate 1 oz., whale oil soap 4 oz., lead arsenate 3 oz. The spray must be applied with force to the opening buds.

A commercial holly plantation in Victoria which formerly was much infested with bud moth but is now fairly free of the pest has been sprayed every year with the following: water 40 gallons, nicotine sulphate ¾ pint, whale oil soap 2 lbs., lead arsenate 1 lb.

Since the majority of the caterpillars pupate in the rubbish beneath the bushes, the dead leaves should be gathered up and burned early in July before the moths emerge.

# The Progress of Parasite Introduction in British Columbia

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As far as is known the first parasite to be introduced into British Columbia for natural control purposes was **Hemisarcoptes coccisugus** (H. malus), a predaceous mite attacking our native oyster-shell scale.

The material was collected in Eastern Canada by Dr. Tothill and sent to British Columbia in 1917, when colonies were liberated at Mission, Vernon, and Agassiz. Further liberations were made at Agassiz in 1920 from material received from Vernon. At Agassiz and Vernon the mite has survived, and under certain conditions has effected excellent control, but has not spread greatly.

In 1922 Mr. Treherne sent material of **Aphelinus mali,** a small chalcid parasite of the woolly-aphis, which was liberated by Mr. E. Clarke in Vancouver. This also came from eastern Canada and has survived in Burnaby district though without completely controlling its host.

Further importations were made from Ontario in 1929 to Vernon

Shipments of **Calosoma sycophanta,** a predaceous carabid beetle were made to Saanich to combat the tent caterpillar in 1917 and 1918. They have not been seen for many years now and have apparently died out. This is a European insect imported to America to combat the gipsy moth, and the stock received here originated in the New England States.

The year 1928 saw the first shipment of parasites to this province direct from England. These were the first fruits of a scheme instituted by the Imperial Institute of Entomology to assist Dominions and Colonies in the biological control of insect pests.

This has resulted so far in the sending to Canada of parasites of the wheat-stem sawfly, the pine shoot moth, the greenhouse white fly, the European earwig and the lecanium scale, the latter two in British Columbia.

The European earwig and the lecanium scale (Eulecanium coryli L) have caused much concern and considerable expense in control work in the coast cities in recent years. The Dominion Entomologist therefore submitted the name of these pests amongst others, that Canada would like to receive parasites for.

In response to this request, 1218 puparia of the tachinid fly **Digonochaeta setipennis** Fall were shipped in 1928, 1929 and 1930 to the Belleville laboratory in Ontario. They were sent packed in moss in cold storage, and at the proper time in the spring were placed in emergence

cages where the adults came out. The reason for the halt on the journey to British Columbia was to intercept any secondaries that might have been present in the puparia. This had to be performed at Belleville as no properly equipped parasite laboratory is yet established in this province.

From these puparia 761 flies were received alive in Vancouver. They had been sent in wire cages every few days as they emerged, usually about 30 to a cage by express from Belleville to Agassiz, the time occupied on this journey being four days. Only 52 out of 813 flies shipped died en route, most of these succumbing in one shipment through improper handling on the train. In 1930 only 11 out of 348 died, the improvement being due to better shipping cages.

Immediately upon receipt at Agassiz, the cages were inspected for food and moisture conditions and then taken direct to New Westminster where they were liberated. Westminster was selected in preference to Vancouver on account of heavier earwig population and absence of any large control measures.

Endeavours have been made each year since liberation to ascertain if these flies were established, collections of the host earwigs being made each August from the liberation points. Over 4700 were collected and caged in 1929, 1930 and 1931 but no recoveries have been made so far.

We do not know therefore whether Digonochaeta has become established as a result of these liberations. The chances of recovering even one puparia out of the 4700 hosts collected are very small as even supposing that one million pests are present per acre (not at all an exaggeration for earwigs in New Westminster) that gives 640 million per square mile. With 1000 parasites liberated there is only one parasite to each 640 thousand hosts, or granting a productivity of 64 young to each female parasite, which is about right for **Digonochaeta** only one in each 10 thousand would be liable to be parasitized.

Again supposing the effective reproductive rate of the parasite is twice that of the host each having one generation per year, 18 years will elapse before the parasite population equals that of the host, and even in the 14th generation the percentage of parasitism is only 3.†

Biological control does not usually give rapid results. Its value lies in eventually inducing permanent improvement.

The second parasite to be received was the small chalcid **Blastothrix sericea** Dalm. which studies at Farnham House had shown was the chief control factor of **Eulecanium coryli** in England. This scale has caused much damage in and around Vancouver since its accidental introduction in 1903.

On the 16th July, 1928, the first shipment of **Blastothrix** was received from England. These had been sent to Belleville, Ont., and had been sent on from there in situ. They had been three weeks on the road, and it seemed wonderful to look at living insects that had been born in England and had flown in the English sunshine. They were quite healthy, only a

†Adapted from statements of Dr. W. R. Thompson in "The Biological Control of Insect and Plant Pests." H. M. Stationery Office, London, England.

very few males being dead out of the 236 received. They were sent in 1 x 5 inch vials tightly corked without provision for air, and no moisture was provided other than that contained in the raisins pinned to the corks which also served as food.

These little travellers were promptly taken to North Vancouver and liberated in two previously selected locations where the host scale was abundant. Further shipments were received in 1929, consisting of 1032 individuals of which 253 arrived dead. In all 1300 adults have been received from England, just over 1000 being liberated alive in their selected home.

At the time of the liberations, July, their host was in the egg and newly hatched larval stage, and appeared too small for even these tiny insects to use for oviposition, and it was feared that they had arrived at the wrong time. Later studies of the life history, however, explained this.

Search was made in the spring and summer of 1929 for signs of the parasite, and material was collected from the 1928 liberation points, and caged, but no recoveries were made. In the spring of 1930 further collections of the host scale were made from the 1929 liberation points, and on the 29th June upon examining the cages containing the scale infested twigs I was rewarded by observing numerous adults of **Blastothrix** which had just emerged from the fully grown scale. Confirmation of my identification was later received from England where recovered material had been sent, and we then knew that the first successful establishment in British Columbia of parasite from England had been accomplished.

Later scouting over the areas adjacent to the liberation points in North Vancouver, showed that the parasite was freely established, and had been so even in 1929 though missed that year. The parasite colony now covers an area seven miles long by three miles wide and the percentage of scales parasitized this autumn runs from 11 to 53 per cent. with an average of 40%. The greatest distance that the parasite was found to have spread from the liberation points was two miles. This distance was covered by last spring and involves three generations of the parasite. The limits of the fourth or present generations have not yet been determined.

From the above it will be seen that a phenomenal success has attended our efforts, and we have good reason to expect that in a few years we shall feel the beneficial effects of this parasite.

A third parasite recently introduced into British Columbia was the tachinid **Compsilura concinnata** Meig. This parasite was brought here primarily to combat the satin moth. It is a European insect originally brought to America in 1906 as a parasite of the gipsy and brown-tail moths, but it also attacks many other lepidopterous larvae.

The 1300 adults liberated in British Columbia in 1929 and 1930 were obtained from puparia received at Belleville from the United States parasite laboratory at Melrose Highlands, Mass. They were shipped here by express in similar cages to those used for the earwig parasite **Digonochaeta,** and liberated in 1929 at Coquitlam, and in 1930 near Capilano bridge, North Vancouver.

This parasite overwinters as an immature larva within its host, but it has been stated that it cannot do so in young satin moth larvae. The above liberation points were therefore chosen with the object of providing other winter hosts, there being large outbreaks of fall web-worm at these points the year previous. Unfortunately these web-worm outbreaks had just reached their peak and entirely disappeared in the year of liberation owing to native parasitism. In order to offset this condition 3000 web-worm larvae were transferred from Agassiz to the liberation point of 1930, but these also were so heavily parasitized that none survived to be attacked by **Compsilura.** There was also a total absence of the woolly-bear larva of **Diacrisia** in these localities so that no recoveries of **Compsilura** have yet been made.

These facts are related here merely to show how success may often depend upon phenomena entirely outside our control.

The establishment of **Compsilura** would be very beneficial in British Columbia as the satin moth has become a serious pest especially in the lower Fraser valley, and it has been found to parasitize as high as 70 per cent. of the larvae of this insect in the eastern United States.

# Notes on the Termites of British Columbia

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Owing to the increasing importance of Termites in the Pacific States to the south of us, it seems not out of place at this time to bring together certain notes on the distribution and some of the outstanding characteristics of the Termite species of British Columbia. The distributional records are taken from the collections at the University and the habits are described from personal unpublished notes supplied by Professor G. J. Spencer and by quotations from Banks' and Snyder's "Revision of the Nearctic Termites," supplemented by some of my own observations. I am indebted to Professor Spencer for supplying me with his notes and for permission to use the material at the University, which is mostly of his own collecting.

The most commonly observed termites on the mainland of British Columbia may be one or other species of the genus **Termopsis** which is, in many respects, the most generalized genus of Termites. The two species concerned are **T. augusticollis** Hagen and **T. nevadensis** Hagen, whose winged form are about the same size, namely an inch from the head to the tip of the folded wings. The structure and habits of the two species are so similar as to be easily confused, while the nymphs and soldiers are practically indistinguishable. However, the flying forms can be readily distinguished, **nevadensis** being smaller and darker with the abdomen in some cases nearly black. A third and somewhat uncommon species, is **Reticulitermes hesperus** Banks which can be readily distinguished from the others by its smaller size, the winged forms being only one centimetre long and the wingless ones still smaller.

As far as I am aware, British Columbia is the only Province in Canada where termites occur and since, as Snyder remarks, " . . . no locality in the world has yielded more than nine species of Termites," it would seem that our having three species, is a very generous allotment.

With regard to the **Distribution** of the species in the Province, **T. augusticollis** is recorded from as far north as Skidgate, about midway on Queen Charlotte Islands (lat. 53° N.) (C. H. Crickmay), from the west coast of Vancouver Island at Long Bay and at Tofino (G. J. Spencer) and very commonly on the south east part of Vancouver Island and the lower mainland. **T. nevadensis** has apparently very much the same distribution on the lower mainland and on Vancouver Island as the above species, and in addition has been taken in flight at Salmon Arm, at the head of the Okanagan valley in the Interior (H. Leech) **Augusticollis** seems to occur more commonly around Vancouver and New Westminster while **nevadensis** is the prevailing species around Victoria. Nymphs of one of these species have been taken freely in early spring from Van Anda, on Texada Island, in the Gulf of Georgia

(Spencer). **R. hesperus** occurs fairly commonly at Departure Bay near Nanaimo, and has been taken at Goldstream (Spencer) and at Langford Lake (G. Beall), both near Victoria.

**Observations on the species.** Both genera occurring in this Province are characterized by absence of the worker caste, the sexual nymphs playing the role of workers to a certain extent. Thus in a caged colony of **augusticollis,** I have several times seen larger nymphs presenting pellets of excrement, upon which members of colonies feed to some extent, to soldiers. Snyder mentions that in the two larger forms, normally-winged, short-winged and wingless, sexual forms occur; also that in **R. hesperus** the soldiers occur in two distinct forms, both short-headed and long-headed.

**Flight.** In the latitude of Vancouver and Victoria, **augusticollis** flies chiefly about the first week in September while **nevadensis** flies about two weeks later. Delayed flights of both species may occur considerably later into the autumn; thus an individual of a small swarm was taken at the University flying in the open on 16 December, 1930. At Tofino on the west coast of the Island, **augusticollis** flies in August. Speaking of California, Snyder says that this species flies from the end of November until May. **R. hesperus** has been taken swarming at Departure Bay, Nanaimo, just about the middle of August (Aug. 13) for two seasons (A. Berkeley, V. Lucas). The flights are apparently of short duration, shorter than in the case of the two larger forms.

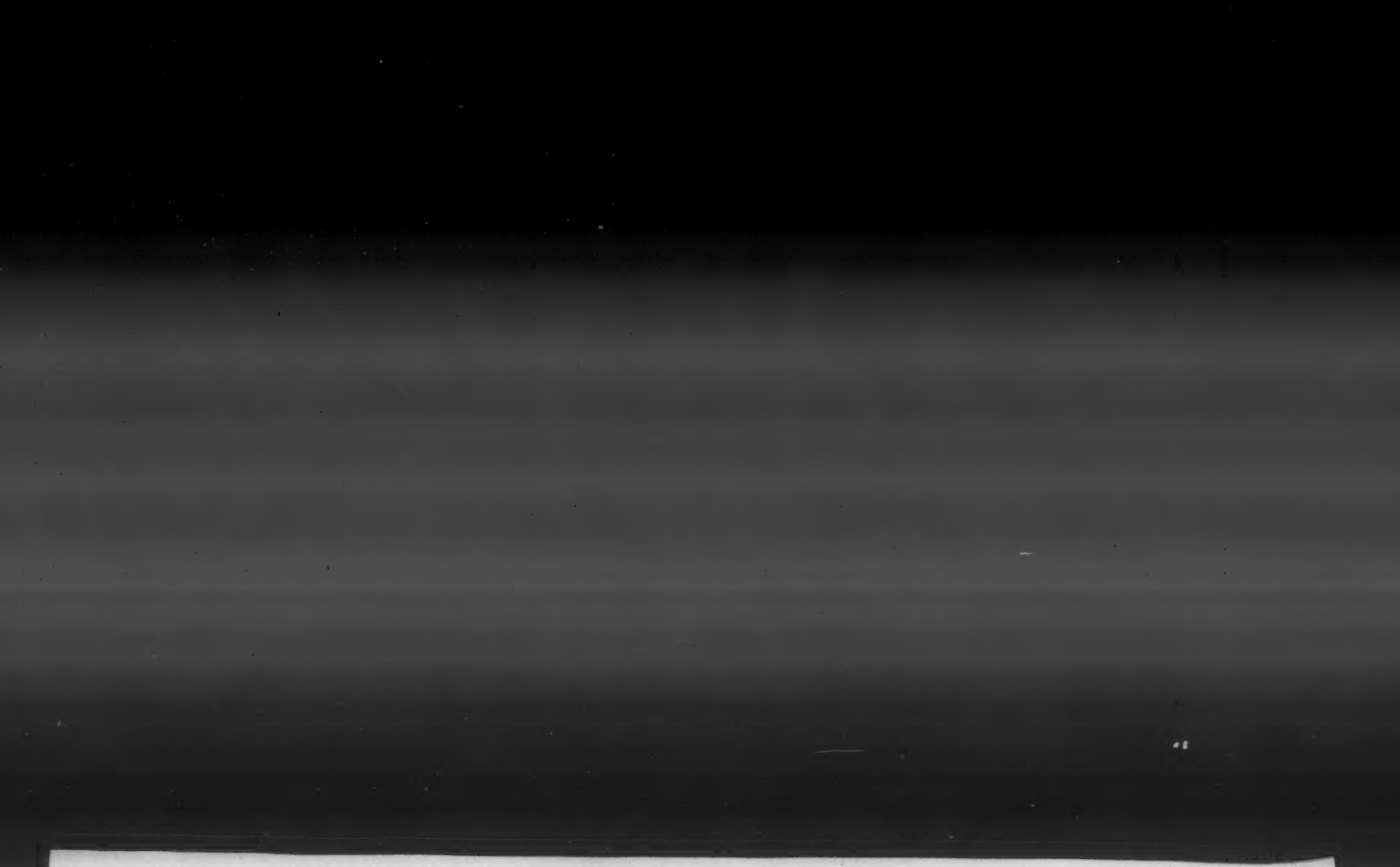
**Local habitat.** The species of **Termopsis** are found in old stumps and logs, especially if the latter are partly buried; they have been found fairly abundantly in the thick plank walls of old sunken greenhouses. From these latter locations they may swarm at any time during winter, irrespective of the season and then the whole flight usually perishes as soon as it encounters the sudden cold outside. In the region of New Westminster practically every old stump and log has its **Termopsis** colony and yet, strangely enough, the colonies are invariably very small and are generally to be found in the soft outer shell of the stumps. Around Victoria, on the other hand, **Termopsis** colonies are often very large and are generally to be found honey-combing the heart of a stump while leaving the surface intact and hard. Moreover, in Victoria, I once found a number of nymphs and a soldier coming up from a hole in the ground and attacking the under surface of an old board, notwithstanding the fact that most workers have shown that the two species of **Termopsis** in question are **not** subterranean in habit. Again it has generally been considered that these species do not build definite nests, yet my observations show that there seems to be a tendency to keep small nymphs in droves or nurseries in separate parts of the colonies, I have also seen, in spring, a colony with soldiers, large nymphs and sexual members, all in a central fissure of a log, with very young nymphs in side galleries. Another instance of this nesting habit or at any rate, the necessity for restricted spaces, was shown in a colony of **T. augusticollis** which I kept in a shallow glass-topped observation cage for two months, and noted that the termites built up several straight walls of excrement between the glass and the floor to a height of 3/8 of an inch.

One curious point of Termite habit was noted once in New Westminster, when a colony was found in which the galleries of **Termopsis**

were so intimately mixed with those of the carpenter ant that the two very diverse forms seemed almost to be using the same nest.

Concerning the habitat of **R. hesperus** . . . one colony found by Professor Spencer near Nanaimo, occurred in an old fallen tree lying in the open on a bare slope, the outer shell of the tree being hard and weather-beaten and the core dry and punky. In the same log occurred one of the species of **Termopsis** and a colony of true ants. Not far from this spot a swarm of **hesperus** was seen emerging, on two successive years, from a small hole in a lawn . . . probably from a log which had been buried when the lawn was filled in some years before. Snyder describes **hesperus** as being frequently subterranean and as living at times under old cow-pats and even in living roots. I have found the species twice, at Langford and at Nanaimo; in each case the termites inhabited tender, dry, half-buried wood, lying on warm slopes much frequented by mound-building ants.

In view of the northern occurrence of the two species of **Termopsis,** it is interesting to note their tolerance to **water** and to **cold,** factors usually considered markedly hostile to termites. Around Vancouver, New Wesminster and on Texada Island the genus occurs commonly in the same piece of wood as millipedes, centipedes and sow-bugs, although it generally occurs in the dry parts of the wood. In winter, however, the wood may be uniformly soaked through. Mr. Spencer mentions certain of these unusual habitats . . . a colony was found in a mossy log spanning a tidal spring just above high-water mark at Tofino; another occurred in a log in Long Beach above Uclulet, V.I.; also when the library ground at the University was being levelled in winter time a buried log was removed from a low-lying spot. The log was completely submerged under shallow water and being rotten, came apart on being pried out, disclosing a flourishing colony of **Termopsis** inside. Finally, in January, 1929, in the woods on the campus, a large Douglas fir log which had been tapped for termites for several successive years, was opened again and the termite colony was found in the usual location, within two inches of the outside of the log. The tunnels had been flooded during the winter and the frost had frozen the water so that the insects were found lying motionless on beds of ice. How long they had been so situated could not even be surmised. However, on being removed to a laboratory and slowly thawed out, the insects lived for some months, suggesting that they are adapted to being frozen.

# List of Members

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